Comment on "Approximate Theory for Terminal Velocity of a Freely Falling Body"

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THE note by Stilley[1] ignores the literature on the exact analytical solution for a body falling through a variable density atmosphere. Although the expression for the velocity-altitude relation involves the exponential integral, this is a familiar tabulated function. In Ref. 2, the author developed a simple graphical method for obtaining the solution for arbitrary conditions by linear interpolation of two particular solutions. This reference also cites references going back to a 1944 paper by Munk.[3]

References

[1] Stilley, G. D., "Approximate Theory for Terminal Velocity of a Freely Falling Body," *Journal of Spacecraft and Rockets*, Vol. 4, No. 9, Sept. 1967, pp. 1274–1276.

[2] Squire, W., "Some Comments on Generalized Trajectories for Free Falling Bodies of High Drag," *Jet Propulsion*, Vol. 28, No. 12, Dec. 1958, pp. 838–839.

[3] Munk, M. M., "Mathematical Analysis of the Vertical Dive," *Aero Digest*, Vol. 44, No. 4, Feb. 1944, pp. 114, 213.

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Reply by Author to R. F. Stengel and W. Squire

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I APPRECIATE the contribution by Stengel of further insight into the applicability of the basic terminal velocity prediction approach considered in my Note and his own previous paper, and the contribution by Squires of additional unique approaches and references. Both Comments, however, tend to ignore the basic premise of my brief Note, which reports results only from a preliminary investigation. This brief Note was admittedly an exercise in first-order theory. It was intended for use in preliminary design to predict the asymptote of the velocity profile in order to permit first-cut decelerator sizing and/or terminal velocity prediction. It would minimize the need for repetitive exercise of the more tedious exact analytical solutions or exact computer solutions with which brevity required me to assume that the reader was also familiar. A tabulated integral was used in solutions for the velocity profile by the principal investigator of the effort during which I performed the initial analysis. Once the preliminary estimates were on hand, one of these available techniques could be used more efficiently to study the transient behavior.

The applicability of my results is limited by both the linearization and the assumption of constant drag coefficient. It is not limited to any particular atmospheric curve fit, however. Without further computer analysis at some future date, I cannot be sure that Stengel's example fully substantiates his otherwise pertinent comments. For the example he chose, with 200 fps equilibrium velocity at sea level, my terminal velocity theory predicts only 2–5% deviation of terminal velocity from the equilibrium velocity in the lower altitude region, too small to serve as a basis for generalized conclusions.

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Erratum: Viscous Effects on Hypersonic L/D of Three Classes of Manned Spacecraft

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AN error has been found in the above Engineering Note. The simulated altitudes indicated by the arrows at the top of Fig. 3, p. 1395, are incorrect. The correct simulated altitude values should be 112,000, 180,000, and 292,000 ft.

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